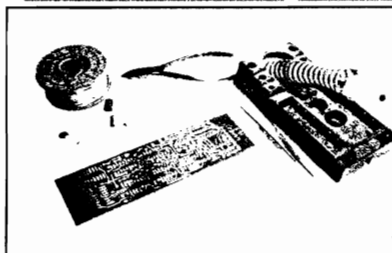


Hot Iron

Issue 36

“Journal of the Constructors Club”

Summer 2002



Editorial

Firstly I must apologise for being late in getting this issue out to you. We had a little bit of a domestic crisis which I am pleased to say is now all over and dealt with satisfactorily! It has also been a bit hectic since I have been involved with the Royal Bath and West Agricultural Show for many years and, due to last year's foot and mouth epidemic we badly needed a good event; the weather did its best to spoil it again for 2 days!

Many of you will also have seen that I have had a fair bit of publicity recently! In Sprat with a special offer for the Wurzel 20/40/80m regen TRF RX for £35 – I am pleased to be able to make the same offer for Members of the Constructors Club. The Dundon 1.5 Watt CW transmitter will work with it and can be made to do all three bands with a little bit of ingenuity! £29+£1 The Compton 80m DC RX has had a review in Radcom by Steve Hartley G0FUW who writes their Newcomers column – to quote ‘Having built a good number of DC RXs, this is one of the best that I have come across.’ I didn't expect it to, but the Compton even survived a reversed supply! And the last piece of publicity is a ‘construction experience’ article by Rob Mannion in PW on his building of the Wurzel – also very positive! Hence my etching tank has been pretty

busy as well! My apologies for the delay.

Contents

- Operating Techniques
- MOSFET Pairs
- Computer Interface
- Pulling Xtal Oscillator
- Inputs to Counters
- Linear Regulators
- Digital Broadcasting
- Digital Radio Mond...
- The ‘Radiator’

Kit Developments

Spurred on by Steve Hartley, I have developed a phone double sideband suppressed carrier 1.5 Watt transmitter called the Butleigh to go with the Compton DC RX. This will do any single band of 20, 40 or 80m and uses the VFO facilities of the Compton. Although the Compton is normally 80m only since its VFO is based on two ceramic resonators, by adding the Mixer kit with a normal VFO, it can be made to do any band to 10m! Furthermore, the Mixer kit fitted with a 6 MHz IF filter and VFO, turns the Compton into a superhet – for any band up to 20m! This can then use the new Kingsdon 5 Watt SSB phone and CW transmitter, this is intended primarily for use with the Midney superhet RX but will work with the Compton when converted to a superhet! The Kingsdon replaces the earlier CW only Kenton transmitter. Since I am working up a new single bander superhet phone TCVR which needs an adapter kit to make it do CW – I have made this CW kit also suitable to convert the Butleigh so that it will do both phone or CW! I also decided that a new harmonic marker kit would be useful – this one has markers throughout the HF spectrum based on odd and even harmonics of 5, 1 MHz, 500, 100 and 50 KHz from a crystal and 3.58 MHz pullable from a ceramic resonator. These options are a bit complex so please don't hesitate to ask!

Somerset Homebrew Contest

This event took place on Mar 24th and was won by Dan Taylor GW0EGH with an unusual home designed rig. As ever, my thanks go to Peter Barville G3XJS and the GQRP Club for organising this event. We have decided that it is time for a change in format and are mulling over future ideas. If you have any suggestions about how to encourage the use of homebuilt gear do let Peter or me know.

Tim Walford - Editor

Operating Techniques Over The Years by Eric Godfrey G3GC

The amateur of today operates on a press of the key, press to talk or even to just talk to change from receive to transmit. This is of course very convenient but is a far cry from the techniques employed by the early experimenters and amateurs. It is just a hundred years ago on 12th December 1901 that Marconi made his first radio crossing of the Atlantic but it was not until the early twenties that the first two way Atlantic contact was established by amateur radio.

In the twenties and thirties virtually all amateur transmissions were crystal controlled. In fact to get a licence in this country you had to produce a 'Crystal frequency Certificate with your application to the GPO for a licence. Most people had only one crystal when first starting in amateur radio but as time went on a second or perhaps even a third might be acquired. The fact that the transmitter was on a specific frequency in the amateur band, necessitated the use of different techniques from those used today. Assuming that you put out a CQ call on 40m, then it was most unlikely that anyone hearing your call would have a crystal on the same frequency. So you would have to search through the whole band from 7 to 7.3 MHz (although they were Megacycles per Second in those days) until you came across someone calling you. Then he, after having given you sufficient time to find him, would send 'K' at the end of his transmission and you would call him on your own crystal frequency and thus a contact would be established. Today we would call this split frequency working. It is obvious that to search through the whole 300 KHz took quite a long time and so a series of unofficial 'Q' codes were used to indicate how you would be searching the band. They were QLH for the low frequency end to the high, QHL for high to low, QLM for low to middle, QMH for middle to high, QHM for high to middle and QML for middle to low. The use of the latter four codes effectively halved the bandwidth to be searched but put a restriction on those who did not have crystals in both halves of the band. Crystals were not cheap and in 1937 one from the Quartz Crystal Company (QCC) with a frequency certificate would cost fifteen shillings which was about three-quarters of a weekly wage. As an aside it might be worth pointing out that British stations were not permitted under the terms of their licence to call 'CQ'. This was because we were not licensed by the GPO as 'Amateur Transmitting Stations' but as 'Experimental Transmitting Stations'. We got round this by calling 'Test de G***' but everybody round the world knew we meant 'CQ de G***' and responded accordingly.

In the late thirties, with the introduction of pentode valves having a low anode to grid capacitance, it became possible to make reasonably stable oscillators, allowing amateurs to wander about the band rather than being 'rock bound'. Wander about is an appropriate description as the oscillators tended to drift due to the fact that there was a considerable amount of heat from the valve's heater and also the heat, and thus the temperature around the oscillator, increased when the key was down. Nevertheless they were a great advantage over being crystal controlled. The advent of this freedom meant new techniques were used to get contacts. Obviously you could tune to the frequency of the station calling 'CQ' but how did you know when you were on his frequency? Well the answer was for you to be able to hear your transmitter oscillator frequency whilst still listening to him. You then adjusted the frequency of your transmitter oscillator until you heard the beat note, this was then tuned for zero beat. However this meant that your transmitter frequency differed from the received station's frequency by the pitch of the beat note. In fact this was not a problem since in those days most receivers were wide open with a bandwidth of many KHz. After the war when proper IF filters were coming into use, you then had to adjust the beat note of your oscillator to be the same as the frequency as of the beat note of the incoming signal. It was also necessary to be sure that you used the correct sideband. Since those days much progress has been made by the manufacturers of black boxes so that now you always transmit and receive on the same frequency unless you specifically intend not to do so. The most modern equipment even have memories so that you can instantly change frequency. It may be worth remembering that the crystal controlled transmitters with the consequent searching of the band were still in use on 2 metres in the sixties and early seventies. I was crystal controlled on 2 metres until June 1970.

In my opinion it is an unfortunate fact that progress has taken away much of the skill, pleasure and sense of achievement from operating an amateur radio station.

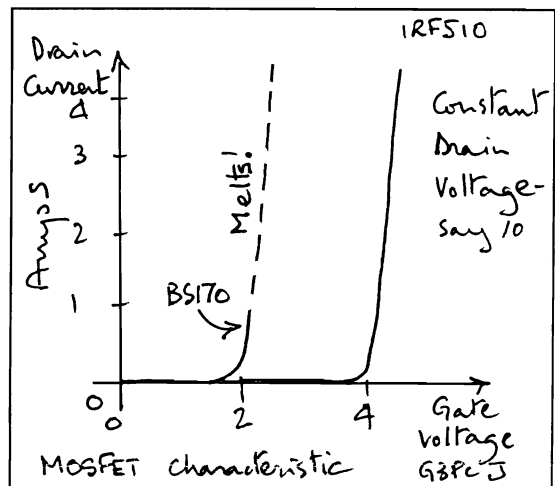
Eric Godfrey G3GC

The MOSFET Pair

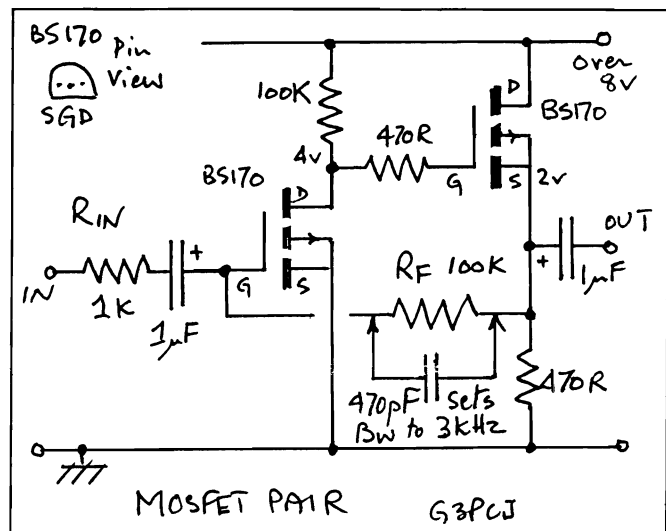
Field effect transistors (FETs) are very useful devices and come in many forms. They are characterised by the gate to source *voltage* controlling the *current* through the device. Many experimenters will be familiar with the depletion mode junction FET such as the common 2N3819 – it is said to be a depletion mode device because with zero gate bias voltage there is still a useful current flowing through the device from drain to source and the normal bias arrangements tend to decrease this zero bias current. They are available in both polarities.

Metal Oxide Semiconductor field effect transistors (MOSFETs) usually have no significant current flowing through them with zero gate bias voltage; they require a significant gate voltage with respect to the source to make a useful current flow from drain to source - hence are said to be enhancement mode devices. This 'forward' bias is typically in the range of 2 to 5 volts depending on type. Again they are available in both polarities with a huge variety of power ratings. 'n' type devices where the drain and gate are normally positive with respect to the source are the most common and usually cheaper. The low power type BS170 is one such device which requires about 2 volts on the gate to turn it on – see below. The IRF510 is another.

The gate terminal of a MOSFET looks like a capacitor so has a very high input impedance; for the BS170 it is typically a few tens of pF and draws effectively zero gate current. This makes biasing very easy! In the simplest common source amplifier arrangement, a single high value resistor from drain to gate will suffice – this makes the current through the drain resistor adjust till the drain DC voltage, and hence gate voltage, is equal to just over 2 volts which is that required to turn it on. The drain resistor can be chosen to give the desired gain (and current) bearing in mind circuit capacitance and hence realistically achievable bandwidth. Note that increasing the supply voltage will increase the drain current but the drain voltage will remain pretty close to 2 volts since only small changes in gate voltage cause large changes in drain current. The device is also highly suitable as a buffering source follower with unity voltage gain. Since the device bandwidth is very large (well into VHF) there is the potential for unintended oscillation unless a 'gate stopper resistor' is added – this need be only a few Ohms but can be higher depending on the desired actual bandwidth.



By combining the common source amplifier stage with the source follower in a feedback pair, as shown right, we have a very versatile arrangement usable from audio to high HF! It provides voltage gain and a low output impedance. The amplifier stage drain voltage will be just over 4 volts DC, so giving a buffer stage source voltage of about 2 volts to turn on the amplifier stage; this will therefore allow a signal swing of up to plus or minus 2 volts peak. Normally one would try to keep the signal levels well below these limits. (This signal excursion range can be doubled by adding another resistor, equal to the feedback resistor, from amplifier gate to ground so that they act as a voltage divider.) The amplifier stage drain resistor needs to be low enough to drive the capacitance of the buffer stage at the desired frequency and extra resistors/capacitors maybe added for decoupling and or to reduce device dissipation in either stage. The circuit shows a speech amplifier circuit for a microphone where the pair of devices are actually acting like an operational amplifier – the effective voltage gain is the value of R_F divided by R_{IN} as long as this is below the open-loop gain of the pair of devices. In this example, used in the Butleigh phone TX, the voltage gain is set to 100 for the speech amplifier. A similar arrangement (with different device currents, gains etc.) is used for the Butleigh's RF driver stage. A very useful circuit configuration! G3PCJ

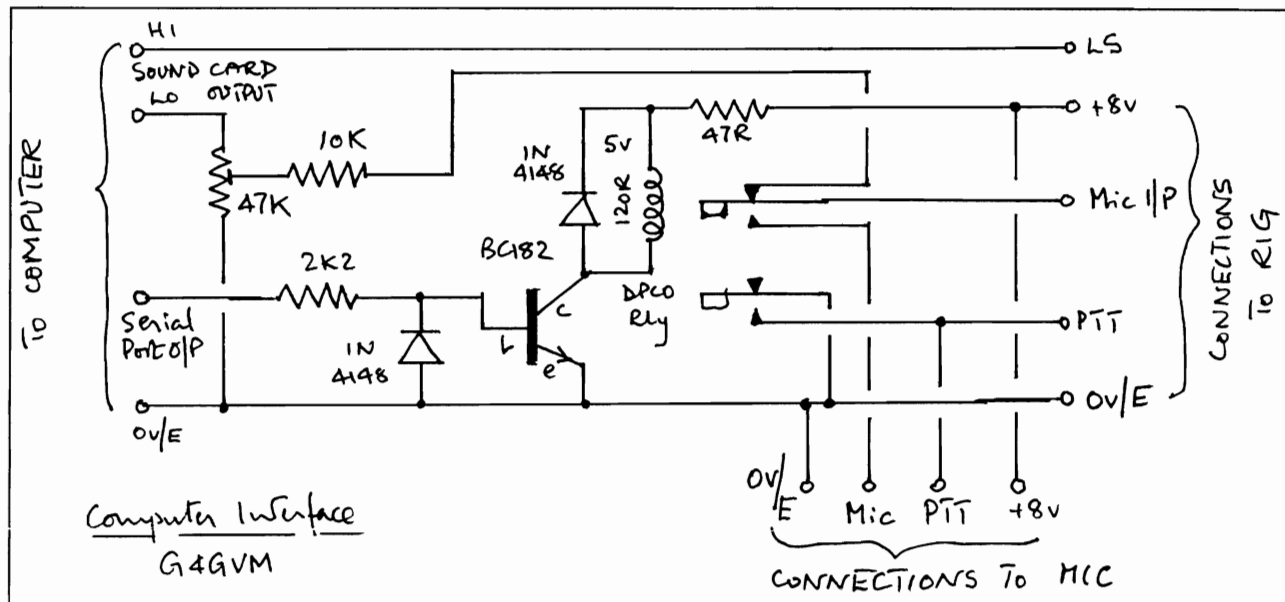


Computer Interface for SSTV and PSK31 by Derek Alexander G4GVM

I suppose there are a number of circuits available, two of which I have seen published, one with the PSK31 (DigiPan 1.6) program itself and the other in SPRAT 106. They all require a certain amount of adapting with plug and socket arrangements to suit one's particular Rig.

I use home-brew equipment (the Yeovil) where it is necessary to unplug the microphone to gain access to the mic input circuit. In order to speak between pictures without a deal of re-plugging during the QSO etc, a more comprehensive design was needed. The circuit to be described automatically allows a microphone to be used when the computer is not actually sending.

I have not found it necessary to isolate the Rig from the Computer with transformers; indeed I found the matching of impedances a problem. Others may not of course! G4GVM.

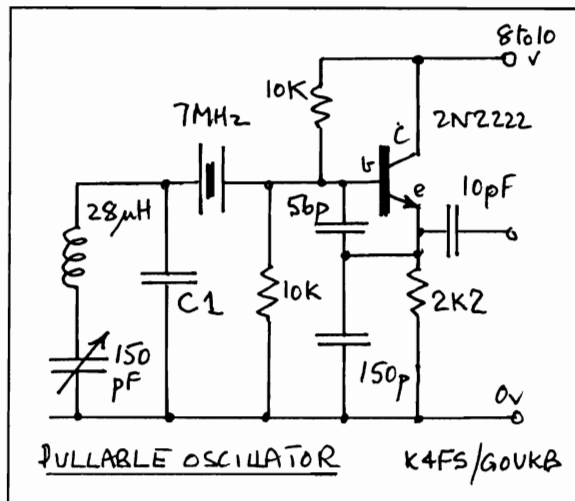


Pulling a crystal oscillator

You may recall that the Construction Challenge at this years QRP Convention was to obtain the largest pulling frequency range of a nominal 7 MHz oscillator. The winner was Brian Jones G0UKB who used some ideas which he saw in a 1998 QRP Quarterly from the USA. He kindly forwarded me a copy of the article by K4FS who did many experiments. Brian managed to get a truly remarkable pulling range for a crystal oscillator such that I wonder if it can really be called a crystal oscillator!

It is based on an ordinary Collpits crystal oscillator which has inductance added in series with the normal trimming capacitor – so far nothing unusual! However the original author added some small extra capacitance C1 across these 'normal' frequency trimming components as shown below.

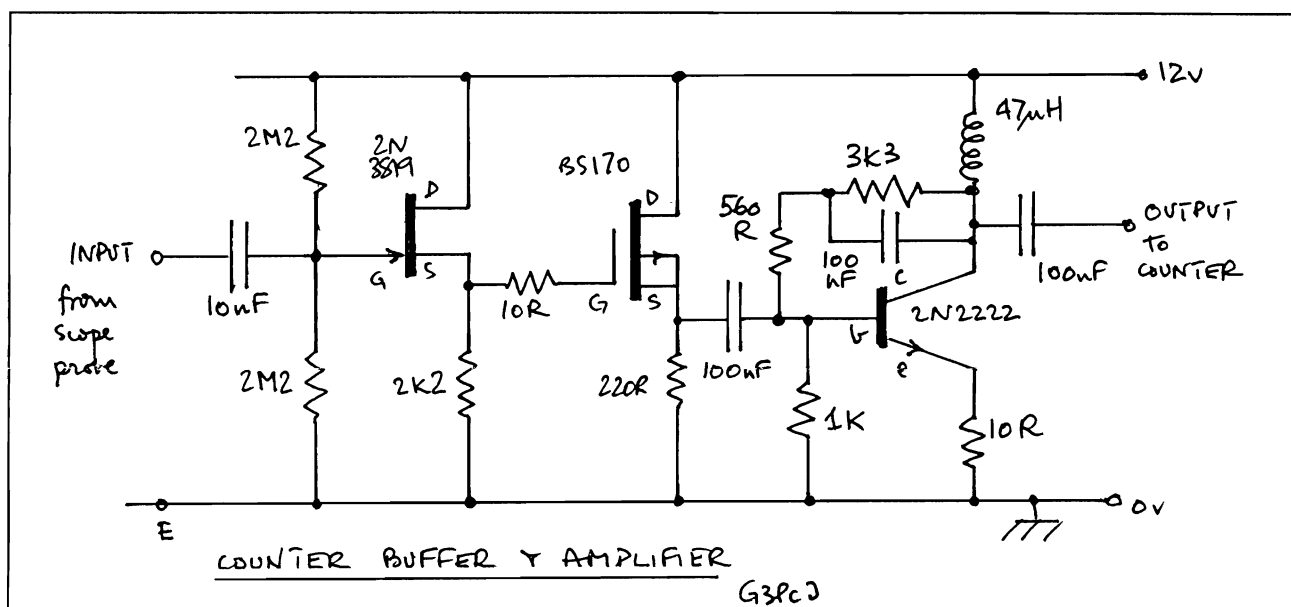
The technique can be used in most bands but for simplicity I give his findings for 40m. K4FS used a 150 pF trimmer and a 28 μ H inductor actually made up of two in series to avoid unwanted resonances. With C1 omitted, the pulling range was just 5 KHz as one might expect. K4FS found that adding 6 pF for C1 increased it to 11 KHz but using 10 pF for C1 enabled 33 KHz. Brian reports that he later managed to get his 40m version to go down 300 KHz but he didn't tell me the circuit. He does comment that there is now some small drift and chirp when switched on! I am pretty confident that with that coverage it is not the crystal that is defining the frequency but the other L and Cs! Nevertheless a good experiment – well done Brian! G3PCJ



Counter Input Amplifier

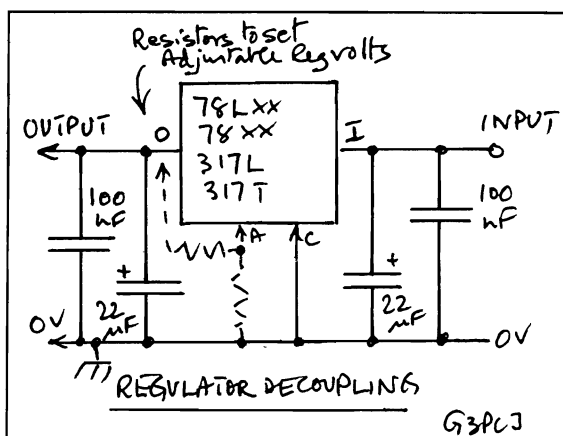
Craig Douglas G0HDJ writes that he has difficulty connecting a slightly insensitive counter to various oscillator circuits, and that when adding a scope probe for buffering purposes, it could only be driven by a signal generator! Clearly more gain was needed but Craig's experiments with two other 'amplifier' circuits did not provide the solution. Had he used both of them (almost literally) it would have done the trick!

The input circuit of the counter had an input impedance of around 1K so connecting it direct to the circuit under test would be quite likely to load it and probably stop it oscillating. The first amplifier that Craig added could easily drive this load but this amplifier had an even lower input impedance, intended for use with a 50 Ohm output impedance circuit! Hence it killed everything it was connected to. Adding the scope probe in front of this increased the load on the oscillator so that it now worked; however the scope probe needs to work into 1M typically so its attenuation was almost total and hence no joy! Craig tried a buffer circuit on its own but there was still insufficient sensitivity in the counter. The solution is to use a buffer circuit after the scope probe and then to amplify the signal to recover that lost in the probe (and maybe more for an insensitive instrument) ready for the normal input stage. Most scope probes attenuate the signal by factor of ten. They have an input resistance of 10M shunted by a few pF typically and expect to have a load on them of 1M and 30 pF – typical of the input of an oscilloscope. Scope probes are practically useless when set to x1 - if they can be! The following circuit should be cheaper than buying a new counter! G3PCJ



Linear Voltage Regulators

Craig Douglas G0HDJ prompts me to explain the decoupling requirements for 78 series devices. These should be decoupled on their input and output by at least 100 nF capacitors – see circuit right. This applies to all versions – irrespective of power rating, polarity or voltage. They need an input supply that it is at least 2 volts more than the desired output. It is quite permissible to use much bigger capacitors (in & out) to give better transient performance. All of the above comments also apply to the linear adjustable regulators of the '317' series. Where excellent regulation is particularly important (e.g. for tuning diode voltages), use the adjustable ones – they are about 10 times better! The more modern Low Drop Out (LDO) regulators can tolerate a lower incoming supply for a particular output voltage but their regulation is not really good enough for tuning purposes. They do however nearly always need an actual minimum of 10 μ F on their output, so one should use 22 μ F to allow for the wide tolerance of electrolytic capacitors. Often other parts of the circuit might need big capacitors on the supply rail – so the general advice is 'use plenty of capacity on input & output!' Switching regulators are best avoided in radio equipment because they are likely to generate unwanted hash or birdies.



Digital Radio Mondiale (DRM)

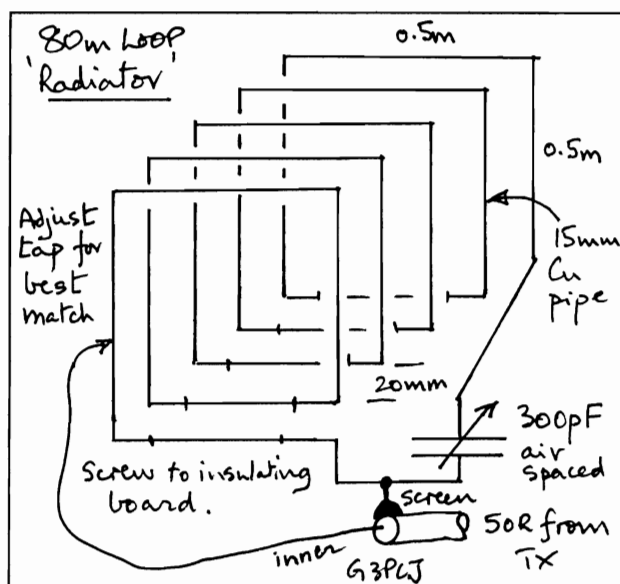
This is a new internationally recognised system for broadcasters that is intended to re-invigorate the broadcasting bands below 30 MHz! Despite the possibilities with satellites, the use of the traditional HF bands for broadcasting has many attractions, mainly associated with the coverage that can be achieved with simple systems for transmitter and receiver – the snags to be overcome are poor audio quality and lack of user friendly facilities! Inevitably, the solution to improving these aspects is the use of digital technology – both for encoding the signal to improve sound quality, and for control to make it more convenient for users.

Given that existing Amplitude Modulated (AM) transmitters will operate alongside DRM ones for many years, they have to be compatible with each other. Hence the new system has to fit within the 9 or 10 KHz channel spacing that is now used worldwide for LF, MF and HF frequency allocations. This is a severe constraint for a digitally encoded audio signal aiming for 15 KHz CD like quality! It can be done apparently using a mixture of Advanced Audio Coding and Spectral Band Replication - these are techniques that have been developed for audio and video compression already (DAB/MPEG4 etc.). They eliminate the redundancy in conventional sound and use the time freed up by this, to send the other helpful command information. Each transmission will have its own station identification and lists of alternative frequencies carrying the same service so that the intelligent (complex!) receiver will be able to automatically retune and select the best source for a particular programme. Despite such radical alterations, an objective has been to minimise the changes required in the expensive high power RF sections of an existing transmitter. A complex form of modulation is used with many sub-carriers conveying different aspects of the audio & control information. Inevitably a Fast Fourier Transform processor features in both transmitter and receiver with a need for very high accuracy of the clock oscillators in both, together with a beefy dedicated micro-processor! Within the entire LF to HF spectrum, the range of signal levels currently exceed the dynamic range of available analogue to digital converters that will be required in the RX. Luckily the very strong LF and MF signals can be reduced somewhat while still allowing adequate signal to noise for the more needy top end of the HF spectrum. The aim is for the RX to cost below £100!

No good for your HF crystal set! Will it replace the 2 billion AM receivers in use now? G3PCJ

The 'Radiator'

My 80m loop antenna always generates much amusement because it looks a bit like a water heater of some sort! Originally designed for a QRP Construction Challenge, it is a five turn loop made up of malleable 15 mm copper water pipe. This can be obtained from good plumbers merchants. I bought a 10m length and bent it by hand around some sort of former with a side of 0.5 metres. The turns should be spaced at least 20 mm apart to reduce self capacitance and the whole resonated with an air variable of around 300 pF with a good insulating knob! There is no need for an AMU since the feed can be tapped around the loop, usually within the first half turn, to effect best match. There is nothing special about these dimensions, just use what you can get hold of! Great for QRP and fun – not really for more than about 25 Watts due to arcing of the capacitor. Less turns for 40m etc.! G3PCJ



SUBSCRIPTIONS!

I regret it is that time of year again! I shall not be sending any further reminders out, so if you wish to continue receiving Hot Iron, hopefully on time, then please send me your cheque for £6 straight away while its fresh in your mind!

As ever, please do tell me if you have any comments, suggestions or queries – I will do my best to get them answered – your ideas are what will make interesting reading! Many thanks to all of you for your support throughout the year, Tim Walford G3PCJ